dark mornings, it is especially difficult to ascertain either the direction or kind of cloud, and many observers hazard a guess rather than wait to determine the true classification, yet it should be remembered that observations of this character are often of less value than no observation at all and from a scientific standpoint are vicious in the extreme. Every careful, conscientious cloud observation and every well-determined direction of cloud movement is a distinct contribution to science and in this is its own reward.

FROST CONTROL AND RELATED FACTORS.

By J. C. WHITTEN, Professor of Pomology, University of California.

[Dated: February, 1919.]

Heretofore we have thought of protecting plants from cold only by direct methods, such as covering or sheltering the plants or by orchard heating, to raise the temperature of the surrounding atmosphere. This conception was based upon the accepted belief that a given kind of plant inherits a given degree of hardiness; that there is a "critical temperature," above which the plant will live without injury and below which the plant will be injured or even die. Certain kinds of plants are notably hardy or resistant to injury from cold. Others are notably tender and subject to injury even in relatively mild climates.

We now know that while the above factors are true, in part, they do not explain the whole truth in determining the resistance of a plant to cold or to drought or to heat or to any other environmental influence that may favor or oppose the health and safety of the plant. To emphasize this statement we only need to call attention to the fact that a given variety of fruit trees may safely endure low winter temperatures while it is dormant or at rest; that it may be injured by a mere frost after it has started growth in spring; and that a sudden frost may kill it after it has gotten into the accelerated growth of the warmer summer.

The state or condition of a plant at a given time, its degree of ripeness and rest, or its degree of activity and growth governs largely how much cold or other unfavorable influence the tree may safely endure.

Studies made at the Missouri Experiment Station show that normally the sap of a fruit tree is least concentrated (contains the least sugar and digested plant food) during the period of rapid length growth in spring and early summer. Sap becomes more and more concentrated after length growth ceases. The supply of plant food reserves becomes greatest as the tree goes into winter condition.

The earlier a tree finishes its length growth the more concentrated its sap becomes and the more abundant its supply of plant food reserves. The more concentrated its sap the more cold the tree will stand either in winter or during spring frosts. In one plot, peach trees which had continued rank length growth until frost in autumn had all their flowers killed on a night the following spring at a temperature of 27°. The following night the temperature dropped to 22°. An adjoining plot of trees, which ceased length growth early, but which maintained healthy mature leaves until frost, endured this lower temperature safely without injury to their blossoms.

The merits of the new system of pruning, now being advocated, are better understood in the light of the above facts. The prominent feature of the former standard system of pruning is that the trees are severely headed back each winter. As a result, rank new growth is stimulated at the top of the cut-back branches. This rank, tender growth continues to lengthen and to make new leaves throughout practically the entire summer. This prevents early storage of plant food reserves and concentration of sap in the tree.

In the new system of pruning, the main limbs are established as early as possible. Once they are established they are not subsequently headed back. They are pruned by thinning out surplus limbs. Length growth ceases early. The tree early attains a concentrated sap and stores plant food reserves. These slow-growing limbs and leaves become firm in texture and evaporate but little water. There is no rank succulent upper limbs to rob or shade out the parts below. The leaves are not likely to draw water out of the fruit in time of drought. The concentrated sap gives up its water less readily. Such trees will endure more spring frost or more drought, due to their better ripened or perfected tissue and their more concentrated sap.

Judicious summer pruning consists of the removal of any surplus tender, succulent water sprouts that are growing where they are not wanted. Any permanent limbs that are continuing length growth too late may be checked in their growth by clipping them back. Dead, broken, or diseased parts should be removed.

So long as trees can secure ample water to supply their leaves, it is not desirable to reduce the leaf surface more than to check length growth of late-growing limbs. If drought is severe and trees are evaporating more water than can be supplied, evaporating surface may be reduced by judiciously removing the more tender, succulent parts, which are least needed as permanent limbs of the tree. Tender, soft, new leaves evaporate many times more water than older, firmer leaves that formed early in the season. The older, firmer leaves, if healthy, and which take on a dark green color, are more serviceable in the elaboration of plant food reserves.

WHITEWASH THE TRUNKS OF YOUNG TREES TO PREVENT SUN SCALD.

The trunks of young trees should be whitewashed as soon as they are planted in the orchard to prevent sun scald and the drying out of the buds and growing layer. Whitewashing the trunks of young trees should be kept up each winter for the first three to five years after the young trees are planted. Exposed trunks or bare main limbs of older trees are also protected from sun scald if kept whitewashed.

Sunscald is most severe in winter, even though the injury may not be noticeable until summer. The coloring matter in the bark of trees absorbs heat enough from the sun's rays on sunny days to raise the temperature of the growing layer to from 15° to 25° (F.) above the temperature of the air. This renders the cells of the growing layer and buds, especially on the sunny side of the tree, turgid, active, and tender.

As the sun goes down at night, the temperature of the tree falls promptly to the temperature of the air, which may be to freezing or even below. This wide fluctuation of temperature between day and night injures the growing layer and buds.

Whitewashing the exposed trunks reflects the sun's rays, keeping the tree at or a little below atmospheric temperature. This keeps the tissues of the tree dormant, even during a sunny day, and not subject to injury when the temperature drops gradually at night.

Heretofore it was thought that sun scald occurs during the hot dry days of summer. A study of the temperature of the trunks and twigs of the trees during summer shows that this is not the case.

The upward passage of cool water from the roots and its evaporation from the twigs and leaves cools the parts of the tree above ground. During a hot, dry day in summer the trunk and twigs of a tree are usually cooled to a temperature from 15° to 20° below the temperature of the air. This cooling is most marked adjacent to green leaves, which evaporate much water. It is least marked on long, bare trunks and main limbs which have no twigs and leaves to evaporate water. This emphasizes the desirability of preserving rosettes of leaves and short fruiting twigs all up and down the trunks and main limbs to shade and cool the parts where sun scald usually occurs. It also emphasizes the desirability of low-headed trees. These leaves also digest plant food to nourish the limbs, trunks, and roots, maintaining a thicker, healthier annual ring of new sap wood.

If sun scald begins on the south side of the trunk and main limbs in winter, it can continue during summer. Winter sun scald dries out the tissues and opposes the development of sap wood and green leafy twigs on the exposed parts. Cool sap is not readily carried through these dried and injured parts so they are less cooled during hot summer days.

A good whitewash which will stick may be made as follows: Slack 15 pounds of lime, in which 2 pounds of salt and 3 pounds of sulphur are sifted while the lime is slacking. The heat of the slacking lime acts on the salt and sulphur so as to form a wash which will stick. Add water to make a thick whitewash and apply to the tree trunks by means of a spray pump or a brush.

Whitewashing the trunks of young trees or sunscalded parts of older trees is desirable, especially in winter. It is not necessary on older trees with thick bark and which possess twigs that shade the limbs.

ABSTRACTS, REVIEWS, AND NOTES.

BRITISH RAINFALL ORGANIZATION.

On July 25, 1919, in accordance with an arrangement approved by H. M. Treasury, the responsibility for the management of the British rainfall organization was transferred by the trustees of the organization to the director of the meteorological office. In accordance with the terms of the transfer, the publication of *British Rainfall* will be continued and *Symons's Meteorological Magazine* is also assured of continuance in association with the *Circular* of the Meteorological Office.

The news of the retirement of Dr. H. R. Mill on account of his impaired eyesight was recently announced, and has been received with much regret by all who are interested in the study of rainfall. The 19 years of his connection with the organization have shown continuous development of the study of the subject on scientific lines.—*Meteorological Office Circular, 39, Sept. 1, 1919, p. 1.*

THE "METEOROLOGICAL GLOSSARY" OF THE BRITISH METEOROLOGICAL OFFICE.[1]

The title of this exceedingly useful compend is somewhat misleading. It is really a pocket encyclopædia of meteorology and kindred sciences. The name "glossary" suggests that one may find here definitions of at least all the more usual words and expressions pertaining to meteorology, but such is not the case. No meteorological glossary worthy of the name has yet been published. The lists of definitions found in Bartholomew's "Atlas of Meteorology" and Marriott's "Hints to Meteorological Observers" supply even less adequately than the new publication of the Meteorological Office the lexicographic information needed by meteorologists.

Only about 400 terms or subjects are treated in the work under review. Taking the letter "A" as a sample of the book in general, we note the omission of *afterglow, air-drainage, Alpenglow, anchor-ice, anomaly, antitrade, arched squall,* and *atmometer* (*atmidometer*), besides hosts of rarer expressions belonging to the language of meteorology, such as *advection, aelloscope, Æolus, aerobioscope, aeroclinoscope, aeroconiscope, aeroscope, aerotherm, æthrioscope, air-tester, All-Hallown summer, allobar, ammil,* etc.

The size of the meteorological vocabulary is realized by very few meteorologists. The present reviewer has labored desultorily during the past 10 years in gathering material toward a comprehensive meteorological dictionary, including in its scope both scientific and nonscientific terms relating to weather and climate, and although upward of 10,000 terms have already been listed the enumeration is still fragmentary.

While the glossary of the Meteorological Office contains many definitions, it is primarily a series of articles, some of them several pages in length, on topics that either are directly meteorological or have some important meteorological application. Under the latter head we find several physical and mathematical articles of rather exceptional interest to the meteorologist, to whom they supply information not easily obtainable elsewhere in a form so convenient for his use. There are, for example, excellent brief discussions of harmonic analysis, correlation, heat, entropy, and buoyancy.

The articles on purely meteorological subjects represent the fruit of the latest investigations, and are therefore a valuable and indispensable supplement to all existing textbooks of meteorology. Aerological subjects are well represented, and there are succinct presentations of recent views and data relating to such topics as the audibility of explosions, visibility, gusts, eddies, and gradients.

The definitions of terms are generally valid and accurate, though a few are open to improvement. We regret to find that British meteorologists persist in using the word *isopleth* (p. 168) as a synonym of *isogram,* the generic name for the "iso-" lines. Ever since the former term was introduced by Ch. Vogler, in 1877, it has been applied almost exclusively, outside of recent British writings, to an isogram drawn on a system of coordinates at least one of which indicates *time* rather than space. Isograms of this class are described by Hann, in his "Lehrbuch der Meteorologie," 3d ed., p. 91, and in this connection he says: "Der Name 'Isoplethen,' der eigentlich Kurven gleicher Zahlenwerte beteutet, was ja auch z. B. die Isothermen usw. sind, *wird nur auf diese Darstellungsmethode angewendet.*" (Our italics.) The important

[1] Great Britain. Meteorological office. Meteorological glossary. 4th issue. London. 1918. 358 p. 24°. (M. O. 225 ll.)